

## CLAIMS

What is claimed is:

1. A combined cycle power plant system comprising:
  - at least one gas turbine (GT);
  - at least one steam turbine (ST); and
  - at least one supplementary fired heat recovery steam generator (HRSG), wherein the operational ratio of the rated output of said at least one steam turbine to said at least one gas turbine (ST/GT) is greater than 0.75, wherein said supplementary firing of said heat recovery steam generator is substantially continuous, and wherein said power plant utilizes a substantially single pressure bottoming cycle that generates high energy steam to drive said at least one steam turbine.
2. The combined cycle power plant system of Claim 1 wherein ST extraction steam fed feedwater heating is utilized to augment cycle efficiency in said power plant.
3. The combined cycle power plant system of Claim 1 wherein at least one of said supplementary firing and said ST extraction steam is partially displaced by the recovery of energy from generator losses and/or other auxiliaries.
4. The combined cycle power plant system of Claim 1 wherein said HP steam is predominantly at supercritical pressure at rated combined cycle plant output.
5. The combined cycle power plant system of Claim 1 wherein the combined cycle efficiency is approximately maintained at conventional combined cycle efficiency levels by designing the basic steam cycle for an efficiency that maintains the steam turbine generator electrical output as required.

6. The combined cycle power plant system of Claim 1 wherein steam and/or GT exhaust energy is used to supply thermal cogeneration and/or CHP requirements.
7. The combined cycle power plant system of Claim 1 wherein said supplementary firing of said HRSG(s) is optimized to allow said GT(s) to operate at or near peak efficiency by modulating the steam energy level and/or flow of said ST(s) in response to energy load demands on said power plant and thus permitting said GT(s) to operate substantially continuously at or near a peak baseline optimum efficiency level.
8. A combined cycle power plant system comprising:
  - at least one gas turbine (GT);
  - at least one steam turbine (ST);
  - at least one supplementary fired heat recovery steam generators (HRSG), wherein said HRSG utilizes a substantially single pressure boiler, and wherein exhaust gases from the exit of an evaporator section to an exhaust section of said HRSG are cooled primarily by feedwater; ST extraction steam fed feedwater heaters for preheating excess feedwater not preheated in said HRSG; and
    - at least one control for controlling said HRSG such that total supplemental firing energy input at combined cycle plant rated capacity is added at the rate of 30% or greater than the energy input to all GT(s) at their ISO rated capacity and for controlling feedwater flowing through feedwater heating sections of said HRSG for optimum heat recovery.
9. The combined cycle power plant system of Claim 8 wherein single or multiple reheat, elevated steam temperatures, supercritical, ultrasupercritical and/or elevated steam conditions are utilized to optimize the steam cycle thermal conversion efficiency.
10. A combined cycle power plant system comprising:
  - at least one gas turbine (GT);

at least one steam turbine (ST);

at least one supplementary fired heat recovery steam generator (HRSG), wherein supplementary firing adds heat to said HRSG and elevates the exhaust gas energy in said HRSG until there is sufficient energy to convert most or all feedwater flow in said HRSG into steam, and wherein said supplementary firing adds heat to said HRSG to generate high pressure steam within said HRSG as required by said ST; and

at least one control for controlling feedwater flowing through feedwater heating sections in said HRSG for optimum heat recovery.

11. A process of designing a combined cycle power plant, said process comprising:
  - determining a target power plant rated capacity;
  - selecting at least one gas turbine of sufficient capacity to supply 25% to 57% of said rated power plant capacity;
  - selecting at least one steam turbine of sufficient capacity to supply said rated power plant capacity not supplied by said at least one gas turbine; and
  - selecting at least one supplementary fired heat recovery steam generator of sufficient capacity to efficiently recover exhaust energy from said at least one gas turbine and supply sufficient high energy steam to said at least one steam turbine.

12. The process of Claim 11 further comprising selecting an appropriate interconnect between said at least one gas turbine, said at least one steam turbine, and said at least one heat recovery steam generator such that said at least one gas turbine operates at substantially full and/or optimal capacity and said at least one steam turbine is modulated primarily by supplemental firing of said at least one heat recovery steam generator in response to demand loading placed on said power plant.

13. The process of Claim 11 wherein said at least one supplementary fired heat recovery steam generator utilizes a substantially single pressure design.

14. A process of constructing a combined cycle power plant, said process comprising:

- determining a target power plant rated capacity;
- selecting at least one gas turbine of sufficient capacity to supply 25% to 57% of said rated power plant capacity;
- selecting at least one steam turbine of sufficient capacity to supply said rated power plant capacity not supplied by said at least one gas turbine;
- selecting at least one supplementary fired heat recovery steam generator of sufficient capacity to efficiently recover exhaust energy from said at least one gas turbine and supply sufficient high energy steam to said at least one steam turbine; and
- optimizing the ratio of total steam turbine to total gas turbine power output in the approximate range of 0.75 to 2.5 based on capital equipment costs of said at least one gas turbine, said at least one steam turbine, and said at least one heat recovery device, current and projected interest rates, projected plant lifetime, fuel costs, maintenance costs, capital costs, and cost of plant floor space to minimize an overall specific cost (cost/kWh) of power generated by said power plant.

15. The process of Claim 14 further comprising selecting an appropriate interconnect between said at least one gas turbine, said at least one steam turbine, and said at least one heat recovery steam generator such that said at least one gas turbine operates at substantially full and/or optimal capacity and said at least one steam turbine is modulated primarily by supplemental firing of said at least one heat recovery steam generator in response to demand loading placed on said power plant.